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Sustainable Innovation in Coffee Packaging: A Case Study Using the Theory of Inventive Problem Solving

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*Corresponding Author Kenneth Pinandhito Accounting Department, Politeknik Negeri Semarang, Indonesia. Article History Received: 02.05.2025 Accepted: 29.05.2025 Published: 18.06.2025	Abstract: This study aims to improve the quality and innovation of coffee powder packaging design by applying the Theory of Inventive Problem Solving (TRIZ). TRIZ provides a systematic framework for identifying and resolving design challenges by utilizing inventive principles derived from patent analysis. The research focuses on solving key issues in coffee packaging, including air leakage, degradation of product quality during storage, and difficulties in usability. The methodology involves problem identification, TRIZ analysis, concept development, prototyping, and performance evaluation. The prototype was developed using biodegradable multilayer materials and featured a zip-lock closure system for enhanced usability and product preservation. Key TRIZ principles applied include segmentation, local quality, flexibility, and the use of new materials. Evaluation results show that the new packaging design extended product freshness by up to 30% compared to conventional packaging. This research contributes to the field of sustainable packaging innovation by demonstrating the applicability of TRIZ in small business contexts such as coffee SMEs. It offers both theoretical insights and practical solutions for product packaging that are functional, environmentally friendly, and aligned with consumer expectations. The findings have implications for improving product competitiveness and advancing innovation practices in the food packaging industry.
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Introduction

Coffee Powder Packaging Design Research Using Theory of Inventive Problem Solving (TRIZ) is an effort to improve and enhance the quality of coffee product packaging through a systematic and innovative approach. In the coffee industry, packaging has a very important role because it is not only a container for the product, but also plays a role in maintaining quality, durability, and consumer appeal. Thus, effective packaging design not only affects sales but also the overall consumer experience of the product.

Theory of Inventive Problem Solving (TRIZ) is a method developed to help solve technical problems in an innovative way. TRIZ offers a systematic framework for identifying and resolving design barriers through general principles found in research on hundreds of thousands of patents. By applying TRIZ in the design of coffee powder packaging, this study aims to produce creative and effective solutions to improve product quality and competitiveness. The background of this research is based on an understanding of several common challenges faced in designing coffee powder packaging. One of them is maintaining the freshness and quality of the product during storage and transportation. Coffee powder is susceptible to factors such as humidity, air, light, and temperature that can affect the taste and aroma of coffee. Therefore, ineffective packaging can result in product damage and reduce consumer satisfaction.

In addition, other aspects to consider are ease of use and convenience in opening and closing the packaging. Packaging that is difficult to open or impractical can disrupt the consumer experience and can even lead to product waste. In this context, TRIZ can provide guidance to identify problems and develop better solutions.

The research methods that will be used include the stages of problem identification, TRIZ analysis, concept development, prototyping, and evaluation. Problem identification involves collecting information about the challenges faced in coffee powder packaging from various sources, such as market research, literature reviews, and direct observation. TRIZ analysis is then carried out

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to identify principles that can be applied in overcoming existing problems.

By applying TRIZ, it is expected to find innovative solutions such as the use of new packaging materials that are more resistant to damaging environmental factors, packaging designs that maintain product freshness longer, or easier and safer opening mechanisms. Once these concepts are developed, prototyping will be carried out to test the effectiveness and practicality of the proposed solutions. Evaluation is then carried out to evaluate the performance of the new packaging in meeting consumer needs and increasing the overall value of the product.

Thus, this research is expected to contribute to the development of better coffee product packaging, which not only meets functional requirements but also improves consumer experience and the competitiveness of the coffee industry as a whole.

Methods

This research was conducted over a six-month period at an SME coffee business located in Wonokasihan Village, Indonesia. The study employed a qualitative descriptive approach to explore and analyze the innovation process in packaging design using the Theory of Inventive Problem Solving (TRIZ). The population in this study includes two primary stakeholder groups: the coffee SME owner and a group of 100 consumers who had experience using the existing coffee packaging. The research variables focused on four key aspects: packaging usability, material performance, consumer perception, and environmental sustainability.

Data were collected through in-depth interviews, direct observation, and consumer surveys. Interviews were conducted with the business owner to identify the limitations of the current packaging, while direct observations were used to examine production processes and existing packaging handling. A consumer survey using structured questionnaires was distributed to collect data on user experiences and satisfaction with the prototype. The research procedures included five main steps: problem identification, TRIZ-based contradiction analysis, conceptual packaging redesign, prototyping using biodegradable materials, and performance testing.

The performance evaluation included storage tests (measuring moisture retention and aroma preservation), usability tests (zip-lock functionality and consumer handling), and consumer perception analysis using descriptive statistics. Data were triangulated through multiple sources including literature reviews, expert consultations, and direct field observation to ensure the validity and reliability of findings. The results were analyzed qualitatively with support from simple quantitative comparisons where relevant, particularly in assessing the effectiveness of the new packaging compared to conventional alternatives.

Results and Discussions

1. Prototyping Results

This study successfully designed an innovative coffee powder packaging prototype using the Theory of Inventive Problem Solving (TRIZ) approach as a systematic framework to solve various design challenges. Problem identification was carried out through observation and interviews with MSMEs and consumers, which revealed key issues such as the inability of packaging to maintain freshness, air leakage, difficulty in opening packaging, and the use of environmentally unfriendly materials. This stage is important in formulating technical contradictions that form the basis of innovative solutions in TRIZ.

Some of the TRIZ principles applied include segmentation (use of zip-lock and double seal), local quality (use of moisture and light resistant inner layer), and new materials (biodegradable material). The prototype was made using aluminum foil and PLAbased multilayer materials that are resistant to oxidation and maintain product freshness for longer. Evaluation of the prototype showed that the moisture content remained stable below 5%, the coffee aroma lasted up to 30% longer, and the new packaging was more visually and functionally preferred by the majority of respondents.

These findings reinforce that the structured application of TRIZ is able to produce packaging designs that not only meet functional and aesthetic needs, but also improve consumer perceptions of quality. This innovation is also relevant to the sustainability trend and can be adopted as a packaging design model for other MSMEs, in line with literature such as Altshuller (1999) and Zhang et al. (2019) which emphasize the effectiveness of TRIZ in encouraging user-based innovation.

Based on data collection from market research, literature review, and direct observation, several major challenges were found in coffee powder packaging: Product Deterioration: Coffee powder is susceptible to air, humidity, light, and temperature which can cause a decrease in taste and aroma quality. Air Leakage: Loose packaging allows air to enter which accelerates oxidation. Difficulty of Use: Consumers often face difficulties in opening and re-closing the packaging. Environmental Impact: The use of packaging materials that are difficult to decompose has a negative impact on the environment.

The packaging prototype is made based on the design concept that has been developed. The manufacturing process is carried out using flexible printing technology and selected biodegradable materials. The developed packaging prototype consists of several key elements:

- Packaging Material: Using multi-layer materials consisting of barrier layers to protect against moisture and oxygen. This material is selected based on TRIZ analysis which shows that the use of barrier layers can reduce the interaction between the product and damaging environmental factors.
- Packaging Design: Packaging is designed with an intuitive opening mechanism, such as a zip-lock or click system, which allows consumers to open and close the packaging easily. This design also considers ergonomic aspects for comfort when used.

Based on TRIZ analysis, several innovation principles applied in packaging design include:

- Segmentation Principle: Packaging is designed with a double seal mechanism to maintain product freshness.
- Local Quality Principle: The inside of the packaging is lined with a special material that is resistant to moisture and light.

- Dynamic Principle: Flexible closure design that allows the packaging to be opened and closed easily.
- New Material Principle: Use of environmentally friendly biodegradable materials.



Figure 1. Packaging that has implemented TRIZ

Shelf life testing was conducted by comparing new packaging with conventional packaging. Coffee powder samples were stored under controlled conditions (temperature and humidity) for a certain period. The results showed that the new packaging could maintain the freshness and aroma of coffee up to 30% longer compared to conventional packaging. The parameters measured included: Moisture content in new packaging remains stable at below 5%, while in conventional packaging, moisture content increases to 10% after 4 weeks. Panel tests were conducted involving 30 panelists who tasted coffee from both types of packaging. The results showed that 80% of panelists preferred the aroma and taste of coffee from the new packaging.

2. Consumer Feedback

Feedback was collected through a survey involving 100 respondents who are coffee consumers. The survey included questions about: Ease of use of packaging, visual appeal of packaging, perception of product quality.

A survey of 100 coffee consumers showed that the new packaging had a significant positive impact on the consumer experience. Around 85% of respondents stated that the new packaging was easier to open and close compared to the old packaging. This shows the success of the application of the ergonomic design principle in TRIZ, especially the principle of dynamics and local segments, which allows consumers to use the product more comfortably and efficiently.

Ease of opening and closing the packaging also reflects an increase in functional usability, which according to Kotler & Keller (2016) is one of the main indicators of product experience. In the context of consumer behavior, usability is part of perceived behavioral control in the Theory of Planned Behavior framework (Ajzen, 1991), which ultimately drives repurchase intentions.

From the visual aspect, 75% of respondents considered the new packaging more visually appealing. They considered the modern design, elegant colors, and complete information to make the packaging more attractive. This finding supports the opinion of Baines et al. (2018) that packaging is a powerful brand communication medium, where aesthetic and informational elements can increase consumer perception value. Visual appeal also contributes to affective value, namely the emotional value felt when consumers interact with the product (Holbrook, 1999).

In addition, 90% of respondents stated that the new packaging gives the impression of better quality. Perception of packaging quality is often associated with overall product quality, in accordance with Zeithaml's (1988) findings which emphasize that perceived value is a combination of quality, price, and non-monetary benefits. In this case, packaging becomes a quality signal that forms a positive consumer perception of the product, even before the product is consumed.

Furthermore, increased quality perceptions can influence consumer loyalty and word-of-mouth recommendations, as explained by Parasuraman et al. (1988) in the SERVQUAL model. This means that good packaging not only impacts the initial transaction, but also creates a long-term relationship between consumers and products.

Thus, the results of this survey confirm that packaging innovation not only impacts functional aspects, but also psychologically and emotionally, which collectively increases customer perceived value and purchase intention. This is evidence that packaging designed with TRIZ principles and considering consumer preferences can be a strong differentiation strategy in a competitive market.

3. Label Design Concept

Label design is also important, especially for MSME products that are still not well known. This is because people's views of the product will first be directed at the existing design. The choice of colors and elements in the logo and sticker design will greatly affect the customer's impression of the product. Therefore, appropriate designs and colors are needed so that this eco-friendly packaging can be accepted and liked.

The basic colors chosen in the packaging label are black and dusty pink. Black gives a luxurious and exclusive impression. And dusty pink is identified with calm and serene. The selection of these colors aims to give the impression that the coffee products sold are exclusive and can calm the mind. Details of the final label and packaging can be seen in Figure 5.2 and Figure 5.3.



Figure 5.2. Packaging Label Design

4. Discussion

The results of the study show that the application of TRIZ in the design of coffee powder packaging can produce innovative and effective solutions. The new packaging not only managed to maintain the freshness of the product, but also improved the consumer experience.

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Innovation in Design: The use of TRIZ principles, such as segmentation and imagery, has proven effective in overcoming problems faced in conventional packaging. Better design not only improves the functionality of the packaging but also adds value to the consumer.

Consumer Satisfaction: Positive feedback from consumers shows that the new packaging meets their expectations in terms of ease of use and visual appeal. This is important to increase consumer loyalty and product competitiveness in the market.

Sustainability: Considering the environmental aspect, this study focuses not only on economic benefits but also on social responsibility. The use of environmentally friendly materials can be a significant selling point in the increasingly competitive coffee industry.

Overall, this research makes a significant contribution to the development of better coffee product packaging, which not only meets functional needs but also enhances consumer experience and strengthens product competitiveness in the market.

The results of the study showed consumer desire for more attractive and informative packaging. Ideal packaging specifications include the use of aluminum foil, yellow color, size 15 x 25 cm, ziplock closure, and complete product information including expiration date and composition. The innovation process involves transforming packaging from ordinary white plastic to a more attractive and functional aluminum foil standing pouch.

5. Managerial and Theoretical Implications

The application of TRIZ in coffee powder packaging innovation not only provides technical solutions, but also produces significant impacts in managerial decision making and the development of product design theory. Managerially, innovative packaging design contributes to increasing product added value, strengthening the competitiveness of coffee MSMEs in the local market, and opening up opportunities for market expansion through product differentiation.

Theoretically, this study integrates the TRIZ approach with the diffusion of innovation theory (Rogers, 2003), which states that the success of innovation adoption is influenced by characteristics such as relative advantage, compatibility, complexity, trialability, and visibility. New packaging that is easier to use, has an attractive appearance, and is environmentally friendly meets all five criteria, thus accelerating consumer adoption.

This study also enriches the theory of consumer perceived value (Zeithaml, 1988) by emphasizing that packaging is not only a functional component, but also influences perceptions of quality, emotionality, and brand image.

Conclusions

This research successfully designed innovative and effective coffee powder packaging using the TRIZ approach. The new packaging not only improves the quality and shelf life of the product, but also enhances the consumer experience.

The results of the study showed that the new packaging designed using multi-layer materials that have a barrier layer can significantly extend the shelf life of the product. The trial showed that this packaging was able to maintain the freshness and aroma of coffee up to 30% longer than conventional packaging. This is very important in the coffee industry, where the quality of taste and aroma are the main factors that affect consumer satisfaction.

Consumer feedback shows that the new packaging is not only easier to use, but also more visually appealing. Ergonomic design with intuitive opening mechanisms, such as zip-locks, enhances user convenience. The survey showed that 85% of respondents felt the new packaging was more practical, and 90% of respondents thought the packaging gave a better impression of quality. This shows that well-designed packaging can improve the overall consumer experience. This study has several limitations. First, the research sample was limited to one MSME, so generalization of the findings to a larger industry scale needs to be done with caution. Second, the evaluation of the effectiveness of the new packaging was conducted in a limited time, so it does not yet describe the performance in the long term and under complex distribution conditions.

Further research suggestions include expanding the scale of the study to several MSMEs or large companies in the coffee sector to validate the TRIZ-based packaging design model. In addition, the integration of digital technology such as QR codes or IoT sensors on packaging can be used as a direction for further research to improve product quality tracking and consumer engagement. Further research can also examine in more depth the influence of packaging on purchasing behavior with a quantitative approach such as Structural Equation Modeling (SEM) to test the relationship between perceived packaging value, satisfaction, and repurchase intention.

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